

## **APPENDIX D**

### **Ecological Baseline Survey of a Sphagnum-Cranberry Bog Near the Fuel Spill-1 Remedial System**

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## **ACRONYMS AND ABBREVIATIONS**

AFCEE	Air Force Center for Environmental Excellence
EW	extraction well
FS-1	Fuel Spill-1

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## 1.0 INTRODUCTION

As part of the final remedial system design for the Fuel Spill-1 (FS-1) groundwater plume, the Air Force Center for Environmental Excellence (AFCEE) plans to modify the existing Quashnet River and bogs pilot treatment system by installing three additional groundwater extraction wells, associated underground extraction and plant discharge piping, and power conduit (AFCEE 2001). The final system design incorporates use of the following existing system features: deep extraction well (EW1), granular activated carbon treatment system and building; surface water discharge bubblers (two currently active and two currently inactive); and reinfiltration trench. The existing shallow extraction well points and associated pump house and piping will not be incorporated as part of the final system. The final design was developed in accordance with the objectives identified in the Record of Decision (ROD) for FS-1 (AFCEE 2000a). The ROD objectives are to:

- Prevent or reduce exposure to groundwater contaminants of concern (COCs) exceeding cleanup standard in groundwater,
- Restore the aquifer to beneficial uses within a reasonable timeframe, and
- Prevent or reduce worker, recreational youth, and adult wader contact with Quashnet River water containing unacceptable concentrations of ethylene dibromide (EDB) and ingestion of fish exposed to Quashnet River water containing unacceptable concentrations of EDB.

The final wellfield design reflects a range of considerations including ecological concerns. Because a significant portion of the final design will be constructed on Mashpee Conservation Land, and groundwater withdrawals have the potential to affect area surface water environments, AFCEE has engaged in discussions with the Town of Mashpee Conservation Agent regarding system construction, permitting under an Amended Order of Conditions, and anticipated system performance and potential impacts. The Mashpee Conservation Agent expressed specific concern that surface water levels in a sphagnum-cranberry bog located 250 feet north of the K1-bog (Figure D-1) may be impacted by pumping during system operation.

As part of the amended Order of Conditions and in order to develop a long-term pumping strategy that minimizes negative impacts to this wetland, AFCEE has agreed to monitor shallow groundwater levels and to complete a baseline ecological survey at the site in response to the town of Mashpee's request for a flora and fauna survey prior to routine operation of the expanded FS-1 remedial system.

This report contains the results of the baseline ecological survey. The baseline survey consisted of an amphibian survey, an invertebrate survey, and a vegetation and soils survey performed during the spring and summer of 2002. This survey provides seasonal pre-operational information that can be used to assist in determining whether potential future ecological changes are associated with operation of the expanded remedial system.

Water level information will continue to be collected prior to system start-up. Baseline water level data and observed surface water response to system hydraulic testing to be conducted at the time of system start-up will be used to formulate an acceptable pumping schedule for the FS-1 system.

## **2.0 STUDY AREA**

The study area is characterized as a sphagnum-cranberry bog and is located due north of the Quashnet bogs and Grafton Pocknet Road in the town of Mashpee, Massachusetts (Figure D-1). The bog is approximately one acre in size and is situated at the base of a deep kettle hole at an elevation of 40 feet mean sea level. The bog receives hydrologic input from atmospheric precipitation, runoff, and potentially intercepts shallow groundwater. A deep, V-shaped ditch appears to have once connected the sphagnum-cranberry bog with the Quashnet bog complex; however, the ditch has been blocked and no longer conveys water. The bog and surrounding upland exhibit evidence of historical cranberry cultivation that appears to have been abandoned within the past fifty years.

Dominant vegetation within the saturated zone of the bog consists of a dense carpet of sphagnum moss (*Sphagnum* spp.) and large cranberry (*Vaccinium macrocarpum*) vines. Several distinct populations of bayberry (*Myrica pensylvanica*), sheep-laurel (*Kalmia*

*angustifolia*), and Virginia chain-fern (*Woodwardia virginica*) have also become established on the bog. The outer perimeter of the bog consists of a narrow band of red maple (*Acer rubrum*) saplings and highbush blueberry (*Vaccinium corymbosum*) shrubs that cast heavy shade over a shallow ditch that supports standing water for most of the year.

Proceeding onto the upland side of the perimeter ditch, the dominant overstory vegetation transitions into mature mixed-oak (*Quercus* spp.), sweet pepperbush (*Clethra alnifolia*), red maple (*Acer rubrum*), white pine (*Pinus strobus*) and pitch pine (*Pinus rigida*) trees. The dominant understory vegetation consists of lowbush blueberry (*Vaccinium angustifolium*) and black huckleberry (*Gaylussacia baccata*) shrubs, along with occasional specimens of swamp azalea (*Rhododendron viscosum*). Pennsylvania sedge (*Carex pensylvanica*) and checkerberry (*Gaultheria procumbens*) were common in the ground cover layer. A few standing dead trees and windfalls are located along the perimeter of the bog. The deadwood snags and stubs provide feeding and cavity nesting opportunities for resident and migratory wildlife species. Overall, the sphagnum-cranberry bog is relatively undisturbed, despite its close proximity to Grafton Pocknet Road and the Quashnet bogs.

### 3.0 METHODS

The following sections outline the methods used in the baseline ecological survey. The methods were performed in accordance with the *Quality Program Plan* (AFCEE 2000d). Methods particular to the types of data collected (e.g., amphibians, vegetation) are cited as appropriate.

#### 3.1 AMPHIBIANS

Amphibian surveys consisted of calling chorus surveys and egg mass surveys designed to identify the species composition and relative abundance of breeding amphibians. Calling chorus surveys were conducted on a weekly basis in accordance with standards outlined in the North American Amphibian Monitoring Program for monitoring anuran (i.e., frogs

and toads) populations (North American Amphibian Monitoring Program 1997). The method focused on identifying species-specific vocalizations during a five-minute period at least one half-hour after sunset (prior to 16 April, calling chorus surveys were conducted during daytime hours). A value of 0 to 3 was assigned based on the following criteria: (0) if no vocalizations were heard, (1) if calls were not overlapping and individuals could be counted, (2) if calls were overlapping but individuals could be counted, and (3) if the chorus was continuous, calls were overlapping, and individuals were too numerous to count. Calling chorus surveys began on 14 March and were completed on 06 June. Egg mass surveys were conducted on a bi-monthly basis and consisted of searching visible portions of the water column and sphagnum mounds for amphibian egg masses. The total number of egg masses and their relative condition were recorded for each species. Egg mass surveys began on 18 April and were terminated on 30 May. General observations of amphibians were also made during the survey for macroinvertebrates.

### **3.2 MACROINVERTEBRATES**

Macroinvertebrate surveys consisted of net sweeps designed to identify the species composition and relative abundance of macroinvertebrates in the sphagnum-cranberry bog. Macroinvertebrate surveys were conducted in accordance with standards outlined in the *New England Freshwater Wetlands Invertebrate Biomonitoring Protocol* (Hicks and Nedeau 2000). In order to account for variation in species composition and abundance, two sampling rounds were proposed for 2002 (one in the spring during the early hatching period and the other in the late summer for the mid-season hatching period). However, only the early macroinvertebrate sampling round was performed on 03-04 June because the bog was deemed too dry as of early August 2002 to perform the second sampling round.

The survey method consisted of designating four evenly spaced sample stations that contained standing water. At each station, replicate samples were collected using fine mesh strainers (1.2 mm grade) that were swept through the water column and the first 3-4 inches of the detritus. To allow for the estimation of the sample area, the net sweeps

were contained within an open-ended 1-foot diameter circular container that was lightly pressed into the substrate. Taxa that were readily identifiable were recorded and released, whereas the remainder were placed in preservative (95 percent ethanol) and sorted and identified to the family level in a laboratory setting. A Bausch and Lomb<sup>®</sup> dissecting microscope (10X – 20X) was used in the identification of the preserved invertebrates. Identification of invertebrate specimens followed *An Introduction to the Aquatic Insects of North America* (Merritt and Cummins 1996).

The vegetation cover at the four sampling stations was recorded, and vertebrate specimens that were either collected or observed nearby were also summarized.

### 3.3 VEGETATION

Vegetation surveys consisted of quadrat sampling and visual encounter surveys to identify the species composition and percent cover of wetland vegetation. A single vegetation survey was performed in accordance with standards outlined in the *Terrestrial Vegetation Field Manual* (Dunwiddie 1986). Plant nomenclature follows *The Vascular Plants of Massachusetts: A County Checklist* (Sorrie and Somers 1999). The survey method consisted of establishing four evenly spaced line transects in which the species composition and percent cover of vegetation was recorded in each of the 53 quadrats. A fifth line transect was established in the northwestern section of the bog to quantify the cover in the sedge community. Vegetation was assigned to standard cover classes (1 through 6), and the midpoint of each cover class was summed to determine percent cover within the 53 sampling quadrats. A visual encounter survey was also performed across the remainder of the abandoned bog to document the presence of unique microhabitats and potential rare species of vegetation. In addition, four uniformly distributed soil cores were collected with a 3-inch Dutch auger and taken within the open bog area to characterize the wetland soil profile (Figure D-1). The vegetation was surveyed on 18 June to incorporate the emergence of the greatest number of plant species.

### 3.4 MISCELLANEOUS OBSERVATIONS

An inventory was prepared for non-focal species of wildlife (e.g., birds, mammals, and reptiles) observed at the sphagnum-cranberry wetland and surrounding upland habitat.

## 4.0 RESULTS

The ecological baseline survey of the sphagnum-cranberry bog assessed amphibian populations, macroinvertebrate populations, vegetation, and soils.

### 4.1 AMPHIBIANS

Assessment of the amphibian populations of the sphagnum-cranberry bog included calling chorus surveys and egg mass surveys.

#### 4.1.1 Calling Chorus Surveys

Two anuran species, wood frogs (*Rana sylvatica*) and spring peepers (*Pseudacris crucifer*), were identified during the calling chorus surveys. Wood frogs exhibited early calling activity that commenced on 14 March and continued for approximately two weeks, whereas spring peepers began calling on 01 April and continued to call until 06 June (Figure D-2). Wood frog calling choruses ranged between levels one and two and were strictly concentrated along the northern portion of the bog ditch. Spring peeper calling choruses ranged between levels one and three and were distributed throughout the bog ditch, with a slight concentration of calling activity in the northeast corner of the bog.

The results of the calling chorus surveys are consistent with the timing and intensity of the species' calling activity that was noted at the sphagnum-cranberry bog during the previous two breeding seasons (M. Moroge, personal observations). Furthermore, the calling chorus results are similar to those obtained at several Upper Cape Cod wetlands and vernal pools during 1999 (AFCEE 2000b, 2000c).

#### **4.1.2 Egg Mass Surveys**

Egg masses from a single species, the spotted salamander (*Ambystoma maculatum*), were identified during the egg mass surveys conducted between 18 April and 30 May. A total of 163 spotted salamander egg masses were located within the perimeter ditch on 18 April (Table D-1). During subsequent surveys, no additional spotted salamander egg masses appeared to have been laid, and many of the original egg masses were not relocated. Also, 4.3 percent of the total egg masses observed during the first survey suffered from degradation of the gelatinous mass and/or embryos. These conditions were likely caused by a combination of invertebrate predation and bacterial infestation. This result is consistent with rates of spotted salamander egg mass degradation that were recorded in several upper Cape Cod wetlands and vernal pools during 1999 (AFCEE 2000b, 2000c).

No wood frog egg masses were located during the egg mass surveys, despite the occurrence of active wood frog calling in late March. Wood frogs typically lay eggs in large, easily recognizable communal masses that contain several hundred to thousands of eggs (Klemens 1993). If any wood frog egg masses were present, they should have been readily detected because the perimeter ditch was searched in its entirety. However, the egg mass surveys did not begin until nearly two and a half weeks after the last wood frog call was recorded. Therefore, it is possible that the eggs either hatched early or suffered from extensive predation or degradation. A single wood frog tadpole was captured during the macroinvertebrate surveys, indicating that at least one of the hatchlings survived to the tadpole stage.

#### **4.2 MACROINVERTEBRATES**

A total of 6.3 square feet of substrate was sampled at the four macroinvertebrate stations. Water depths at the sampling stations ranged from 6.0 to 13.5 inches, and water temperatures ranged from 14 °C to 18 °C (Table D-2). The vegetative cover at the sampling stations consisted of red maple, highbush blueberry, sweet pepperbush, common winterberry, and swamp azalea.

Among the four macroinvertebrate stations, 28 invertebrates were identified, representing an approximate abundance of four to five specimens per square foot. The total number and relative diversity of invertebrate species collected at the sampling stations was relatively low as only five orders (Odonata, Trichoptera, Coleoptera, Hemiptera, and Diptera) were represented in the survey. Common species recorded included dragonfly larvae (family Libellulidae) and water scavenger beetle larvae (family Hydrophilidae). The diversity of species present was lower than expected, possibly because sampling occurred after most of the invertebrate taxa had emerged. Low species abundance was probably also affected by the fact that the bog is without standing water for extended periods during the summer months, hence preventing the establishment of a more diverse invertebrate community.

Although the dragonfly and damselfly larvae collected in the recent survey were not identified to species, past survey work at the Quashnet River Bogs in the summer of 1996 developed a list of species common to the bog area. The results were reported in the Odonate Survey for the Installation Restoration Project (unpublished). Table D-3 provides a list of the odonate species recorded at the Quashnet River Bogs in the 1996 survey.

Vertebrate species were also recorded in the survey (Table D-2, Figure D-1). Spotted salamander larvae were collected at two of the sampling stations (Stations 1 and 4). Spotted salamander larvae were most numerous at Station 1, where the water temperature was 18 °C due to the more open structure of the vegetative community. Green frogs were recorded in proximity to all four sampling stations. An unusual event was the capture of a juvenile snapping turtle (5.0-inch shell length) at Station 2. A single wood frog and several spring peeper tadpoles were also observed outside the sampling bucket at Station 2.

#### **4.3 VEGETATION AND SOILS**

Results of the vegetation sampling are presented in Tables D-4 and D-5. Table D-4 shows the percent frequency and relative frequency calculations for the recorded species.

Table D-5 shows the percent cover and relative cover calculations for the recorded species. A list of vascular plant species recorded in the survey is presented in Table D-6.

A total of 16 species of higher vascular plants were documented in the 1-meter sampling quadrats surveyed at the sphagnum-cranberry wetland. An additional eight plant species were recorded in the meander surveys performed within the sphagnum-cranberry wetland study area.

Sphagnum moss was the most frequently recorded species in the survey at 98.1 percent frequency (i.e., in 98.1 percent of the plots), followed by large cranberry at 67.9 percent frequency, and Virginia cotton-grass (*Eriophorum virginicum*) at 58.4 percent frequency. Tussock sedge (*Carex stricta*) and Virginia chain-fern (*Woodwardia virginica*) both occurred at a 24.5 percent frequency. Individually, sphagnum moss, large cranberry, Virginia chain-fern and Virginia cotton-grass each comprised greater than 10 percent cover in the 53 plots. Tussock sedge and Virginia chain-fern tended to be densely concentrated in defined populations in the northern and southern part of the wetland. Red maple occurred at 28.3 percent frequency with the specimens of red maple forming a scrub-shrub wetland community along the outer margin of the bog. A dense cover of wetland shrubs including sweet pepperbush, swamp azalea, highbush blueberry, and common winterberry (*Ilex verticillata*) occurred intermixed with the red maples along the perimeter of the bog. In general, herbaceous species were absent or sparse due to dense shade under the band of woody vegetation established along the perimeter of the sphagnum-cranberry bog. An occasional associate species recorded in standing water in openings under the woody shrub cover was common bur-reed (*Sparganium americanum*).

Soil samples documented the presence of partially decomposed organic material in the upper 12 to 14 inches. A layer of coarse sand and gravel approximately 1 to 3 inches thick occurred at the surface of the abandoned cranberry bog over decomposed organic material (peat). Peat consisted of decomposed plant (sapric) material over 36 inches deep. This soil profile lends strong support for the contention that cranberries were historically cultivated at the site.

#### **4.4 MISCELLANEOUS OBSERVATIONS**

A total of 29 species of non-focal wildlife were documented at the sphagnum-cranberry wetland and surrounding upland habitat during the course of the formal surveys (Table D-7). No state-listed rare plants or animals were observed during the course of the field surveys.

#### **5.0 SUMMARY**

A baseline ecological survey was performed at the sphagnum-cranberry bog north of Grafton Pocknet Road, near existing and proposed extraction wells of the FS-1 treatment system.

Vocalizations by wood frogs were identified for two weeks starting on 14 March, whereas spring peeper calls were identified from 01 April through 06 June. The only type of egg masses observed during the course of the egg mass surveys (18 April through 30 May) were those of the spotted salamander. However, the observation of a wood frog tadpole and spring peeper tadpoles during sampling for invertebrates suggests that these species successfully laid egg masses and hatched larvae. A total of 163 spotted salamander egg masses was observed, and a small number (4.3 percent) of these egg masses had been destroyed by predation or degraded by bacterial infestation.

Invertebrate abundance in the bog was much lower than expected; damselfly larvae, dragonfly larvae, and water scavenger beetles dominated the existing community. The estimated abundance of macroinvertebrates was four to five individuals per square foot. Vertebrates (frogs, tadpoles, spotted salamanders, and a snapping turtle) were also observed in samples or near sampling stations. The bog was dry by early August 2002, so a midseason survey could not be performed.

The vegetative community within the saturated zone of the bog was dominated by sphagnum moss and large cranberry vines. A dense scrub-shrub wetland community was present along the perimeter of the abandoned bog. Dominant trees and shrubs in the scrub-shrub wetland community included red maple, swamp azalea, highbush blueberry,

and sweet pepperbush, with occasional specimens of winterberry, male berry, and chokeberry. Soil samples were primarily organic consisting of decomposed plant material with small amounts of sand and gravel at the surface.

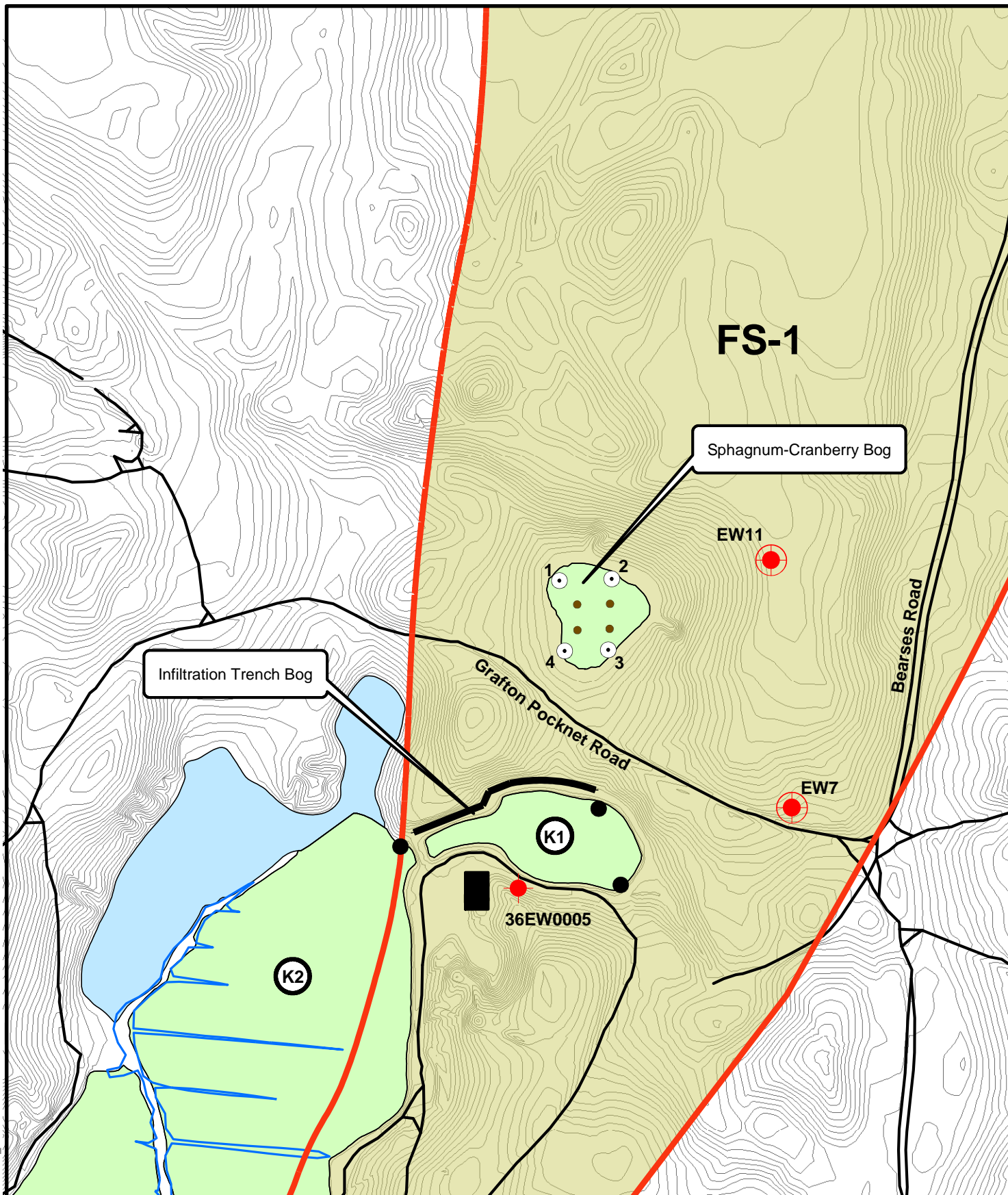
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## **FIGURES**

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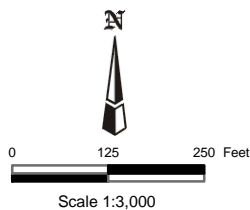


## Legend

- Extraction Well
- Proposed Extraction Well
- Soil Core Location
- Invertebrate Sampling Station
- Aerator (Bubbler)
- Treatment Plant

- 2 Foot Contour
- EDB Plume Contour
- EDB MMCL=0.02 µg/L
- Bog
- Wetland

Note: Contours based on October 2000 fixed well sampling results.  
Plume contours will have changed by the projected start-up date (October 2002)



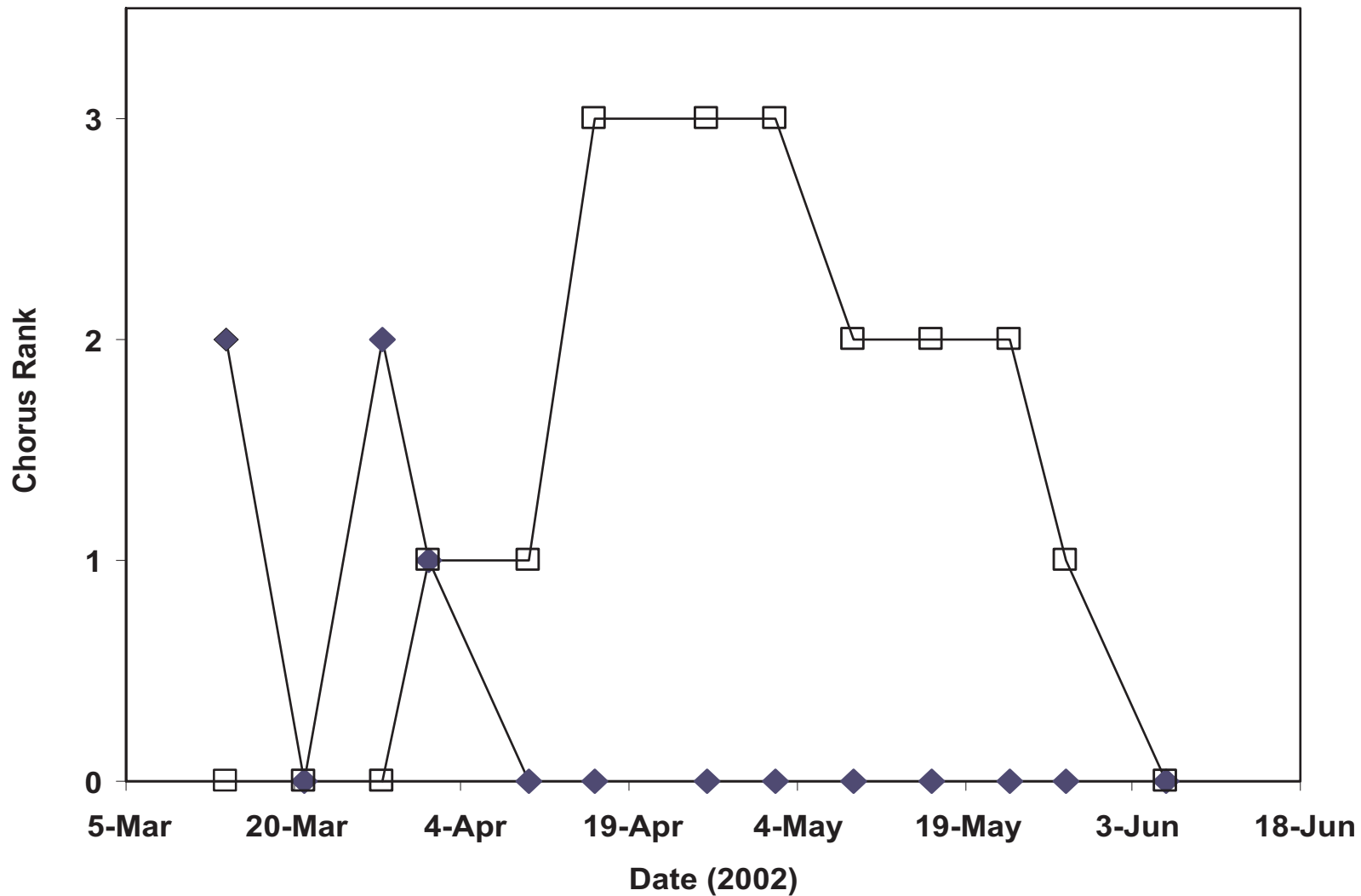
**JE JACOBS**

## Region of Wetland Baseline Study

Massachusetts Military Reservation  
Cape Cod, Massachusetts

NAME: jpicault DATE: 8/24/2002

Figure D-1



# Legend

- ◆ Rana sylvatica (Wood Frog)
- Pseudacris crucifer (Spring Peeper)



Spring 2002 Amphibian  
Calling Chorus Survey

Massachusetts Military Reservation  
Cape Cod, Massachusetts

10/02/02 JG FS1WetBaselineB2.cdr

Figure D-2

## TABLES

**Table D-1**  
**Egg Mass Counts and Physicochemical Characteristics of Water at the Sphagnum-Cranberry Bog**

Date	Species	Number of Egg Masses	Percent Predation	Percent Degradation	Temperature (°C)	Dissolved Oxygen (mg/L)	pH	Comments
18-Apr-02	AMMA	163	7	4.3	20.28	4.61	4.52	Water level appeared to drop 1-2 inches since eggs were laid (early April). Higher average temperature likely the result of survey being performed on a sunny and mild afternoon.
2-May-02	AMMA	90	not recorded	not recorded	7.9	4.05	4.25	Survey performed in the morning. Water level appeared to remain steady at former level. Fate of missing egg masses uncertain; however, overcast weather made observation difficult.
15-May-02	AMMA	51	not recorded	not recorded	10.2	4.66	4.41	Survey performed in the morning. Several egg masses had hatched in entirety.
30-May-02	None	--	--	--	15.6	2.56	4.5	Survey performed in the morning. Egg mass counts terminated because most of the masses had hatched.

AMMA = *Ambystoma maculatum* (spotted salamander)

mg/L = milligrams per liter

°C = degrees Celsius

**Table D-2**  
**Sampling Station Descriptions and Organisms Encountered at the Sphagnum-Cranberry Bog**

	Taxonomy				Site Description/Organism Count			
	Class	Order	Family	Common Name	Station 1	Station 2	Station 3	Station 4
<b>Vegetation Cover</b>					Red maple and highbush blueberry	Red maple saplings, highbush blueberry and swamp azalea	Red maple, highbush blueberry, sweet pepperbush, common winterberry	Red maple, highbush blueberry, sweet pepperbush, swamp azalea
<b>Water Temperature (°C)</b>					18	18	15	14
<b>Water Depth (inches)</b>					8.75 - 9.5	9	10 - 13.5	6 - 8.5
<b>Invertebrates in Samples</b>	Insecta	Odonata	unknown	Damselfly Nymph	1	2		
	Insecta	Odonata	Libellulidae	Dragonfly Nymph	3	7		
	Insecta	Trichoptera	unknown	Caddisfly case	1			
	Insecta	Coleoptera	Hydrophilidae	Water Scavenger Beetle (juvenile)	1			
	Insecta	Coleoptera	Hydrophilidae	Water Scavenger Beetle (larva)	2			8
	Insecta	Hemiptera	Gerridae	Water Strider		1		
	Insecta	Diptera	Culicidae	Mosquito larva				2
<b>Vertebrates in Samples</b>	Lissamphibia	Caudata	Ambystomatidae	Spotted Salamander	15			2
	Reptilia	Testudines	Chelydridae	Snapping Turtle		1		
<b>Incidental Species Observed Near Sample Station</b>	Lissamphibia	Anura	Ranidae	Green Frog	4	1	1	1
	Lissamphibia	Anura	Hylidae	Spring Peeper tadpole		1		
	Lissamphibia	Anura	Ranidae	Wood Frog tadpole		1		
	Insecta	Hemiptera	Gerridae	Water Strider		1		
	Insecta	Coleoptera	Dytiscidae	Diving Beetle larva				1

°C = degrees Celsius

**Table D-3**  
**List of Odonates Recorded at the Quashnet River Bogs**  
**During a 1996 Field Survey**

<b>Suborder Zygoptera (Damselflies)</b>	
<b>Family Caloptergidae</b>	
<i>Calopteryx maculata</i>	Ebony Jewelwing
<b>Family Lestidae</b>	
<i>Lestes rectangularis</i>	Slender Spreadwing
<i>Lestes</i> sp.	Spreadwing sp.
<b>Family Coenagrionidae</b>	
<i>Amphiagrion saucium</i>	Eastern Red Damselfly
<i>Argia fumipennis</i>	Violet Dancer
<i>Chromagrion conditum</i>	Variegated Damselfly
<i>Enallagma civile</i>	Civil Bluet
<i>Enallagma doubledayi</i>	Doubleday's Bluet
<i>Enallagma exsulans</i>	Stream Bluet
<i>Enallagma signatum</i>	Orange Bluet
<i>Ischnura posita</i>	Fragile Forktail
<i>Ischnura verticalis</i>	Eastern Forktail
<b>Suborder Anisoptera (Dragonflies)</b>	
<b>Family Aeshnidae</b>	
<i>Aeshna clepsydra</i>	Mottled Darner
<i>Aeshna</i> sp.	Darner sp.
<i>Anax junius</i>	Common Green Darner
<i>Anax</i> sp.	Darner sp.
<b>Family Gomphidae</b>	
<i>Gomphus</i> sp.	Clubtail sp.
<b>List of Odonates Recorded at the Quashnet River Bogs</b>	
<b>Family Corduliidae</b>	
<i>Epithea cynosura</i>	Common Baskettail
<i>Epithea princeps</i>	The Prince
<b>Family Libellulidae</b>	
<i>Celithemis elisa</i>	Calico Pennant
<i>Erthemis simplicicollis</i>	Green Jacket
<i>Libellula lydia</i>	Whitetail
<i>Leucorrhinia intacta</i>	Johnny Whiteface
<i>Pachydiplax longipennis</i>	Blue Pirate
<i>Perithemis tenera</i>	Amberwings
<i>Sympetrum costiferum</i>	Saffron-bordered Meadowfly
<i>Sympetrum rubicundulum</i>	Ruby Meadowfly
<i>Sympetrum semicinctum</i>	Band-winged Meadowfly
<i>Sympetrum vicinum</i>	Yellow-legged Meadowfly
<i>Sympetrum</i> sp.	Meadowfly

sp. = species

**Table D-4**  
**Calculation of Percent Frequency and Relative Frequency for Vegetation**  
**at the Sphagnum-Cranberry Bog**

Scientific Name	Common Name	No. of Plots (out of 53)	Percent Frequency	Relative Frequency
<i>Acer rubrum</i>	Red Maple	15	28.3	7.3
<i>Carex stricta</i>	Tussock-sedge	13	24.5	6.3
<i>Clethra alnifolia</i>	Sweet Pepperbush	12	22.6	5.8
<i>Decodon verticillatus</i>	Water-willow	3	5.7	1.5
<i>Eriophorum virginicum</i>	Virginia Cotton-grass	31	58.4	15.1
<i>Gaylussacia baccata</i>	Black Huckleberry	1	1.9	0.5
<i>Kalmia angustifolia</i>	Sheep-laurel	3	5.7	1.5
<i>Lyonia ligustrina</i>	Maleberry	1	1.9	0.5
<i>Pinus rigida</i>	Pitch Pine	1	1.9	0.5
<i>Rhododendron viscosum</i>	Swamp Azalea	11	20.7	5.4
<i>Scirpus cyperinus</i>	Wool-grass	1	1.9	0.5
<i>Smilax rotundifolia</i>	Common Greenbrier	3	5.7	1.5
<i>Sphagnum</i> spp.	Sphagnum Moss	52	98.1	25.4
<i>Vaccinium corymbosum</i>	Highbush Blueberry	9	17.0	4.4
<i>Vaccinium macrocarpon</i>	Large Cranberry	36	67.9	17.6
<i>Woodwardia virginica</i>	Virginia Chain-fern	13	24.5	6.3

**Table D-5**  
**Calculation of Percent Cover and Relative Cover for Vegetation**  
**at the Sphagnum-Cranberry Bog**

Scientific Name	Common Name	Total Percent Cover in 53 Plots	Percent Cover	Relative Cover
<i>Acer rubrum</i>	Red Maple	521	9.8	5.5
<i>Carex stricta</i>	Tussock-sedge	306	5.8	3.3
<i>Clethra alnifolia</i>	Sweet Pepperbush	478	9	5.1
<i>Decodon verticillatus</i>	Water-willow	68	1.3	0.7
<i>Eriophorum virginicum</i>	Virginia Cotton-grass	537	10.1	5.7
<i>Gaylussacia baccata</i>	Black Huckleberry	1	<0.1	0.0
<i>Kalmia angustifolia</i>	Sheep-laurel	54	1	0.6
<i>Lyonia ligustrina</i>	Maleberry	15	0.3	0.2
<i>Pinus rigida</i>	Pitch Pine	38	0.7	0.4
<i>Rhododendron viscosum</i>	Swamp Azalea	390	7.3	4.1
<i>Scirpus cyperinus</i>	Wool-grass	1	<0.1	<0.1
<i>Smilax rotundifolia</i>	Common Greenbrier	4	0.1	<0.1
<i>Sphagnum</i> spp.	Sphagnum Moss	3960	74.7	42.3
<i>Vaccinium corymbosum</i>	Highbush Blueberry	472	8.9	5
<i>Vaccinium macrocarpon</i>	Large Cranberry	1931	36.4	20.6
<i>Woodwardia virginica</i>	Virginia Chain-fern	600	11.3	6.4

**Table D-6**  
**List of Vascular Plants Recorded**  
**at the Sphagnum-Cranberry Bog**

<b>Vascular species recorded in the sampling quadrats</b>	
<i>Acer rubrum</i>	Red Maple
<i>Carex stricta</i>	Tussock Sedge
<i>Clethra alnifolia</i>	Sweet Pepperbush
<i>Decodon verticillatus</i>	Water-willow
<i>Eriophorum virginicum</i>	Virginia Cotton-grass
<i>Gaylussacia baccata</i>	Black Huckleberry
<i>Kalmia angustifolia</i>	Sheep-laurel
<i>Lyonia ligustrina</i>	Maleberry
<i>Pinus rigida</i>	Pitch Pine
<i>Rhododendron viscosum</i>	Swamp Azalea
<i>Scirpus cyperinus</i>	Wool-grass
<i>Smilax rotundifolia</i>	Common Greenbrier
<i>Sphagnum</i> spp.	Sphagnum Moss
<i>Vaccinium corymbosum</i>	Highbush Blueberry
<i>Vaccinium macrocarpon</i>	Large Cranberry
<i>Woodwardia virginica</i>	Virginia Chain-fern
<b>Associate species recorded</b>	
<i>Aronia melanocarpa</i>	Black Chokeberry
<i>Betula populifolia</i>	Gray Birch
<i>Calamagrostis canadensis</i>	Canada Bluejoint
<i>Carex</i> sp.	Sedge
<i>Carex scoparia</i>	Broom Sedge
<i>Ilex verticillata</i>	Common Winterberry
<i>Sparganium americanum</i>	Common Bur-reed
<i>Viburnum dentatum</i>	Arrowwood

**Table D-7**  
**Incidental Species Observations at the**  
**Sphagnum-Cranberry Bog**

<b>Upland Species</b>	
Downy Woodpecker	<i>Picoides pubescens</i>
Hairy Woodpecker	<i>Picoides villosus</i>
Black-capped Chickadee	<i>Parus atricapillus</i>
Red-tailed Hawk	<i>Buteo jamaicensis</i>
Blue Jay	<i>Cyanocitta cristata</i>
American Crow	<i>Corvus brachyrhynchos</i>
Tufted Titmouse	<i>Parus bicolor</i>
White-breasted Nuthatch	<i>Sitta carolinensis</i>
Eastern Towhee	<i>Pipilo erythrophthalmus</i>
American Robin	<i>Turdus migratorius</i>
Great Crested Flycatcher	<i>Myiarchus crinitus</i>
Eastern Phoebe	<i>Sayornis phoebe</i>
Mourning Dove	<i>Zenaida macroura</i>
Scarlet Tanager	<i>Piranga olivacea</i>
Prairie Warbler	<i>Dendroica discolor</i>
Common Grackle	<i>Quiscalus quiscula</i>
Gray Squirrel	<i>Sciurus carolinensis</i>
Southern Flying Squirrel	<i>Glaucomys volans</i>
<b>Wetland Species</b>	
Hermit Thrush	<i>Catharus guttatus</i>
Common Yellowthroat Warbler	<i>Geothlypus trichas</i>
Blue Jay	<i>Cyanocitta cristata</i>
Gray Catbird	<i>Dumetella carolinensis</i>
American Goldfinch	<i>Carduelis tristis</i>
Meadow Vole	<i>Microtus pensylvanicus</i>
Spotted Salamander	<i>Ambystoma maculatum</i>
Green Frog	<i>Rana clamitans melanota</i>
Wood Frog	<i>Rana sylvatica</i>
Snapping Turtle	<i>Chelydra s. serpentina</i>
Eastern Garter Snake	<i>Thamnophis s. sirtalis</i>